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FINAL REPORT ON GRANT NSG 5208

"SUPPORT FOR JOINT INFRARED AND COPERNICUS X-RAY  
OBSERVATION OF CYGNUS X-3"

October 26, 1979

(NASA-CR-162357) SUPPORT FOR JOINT INFRARED  
AND COPERNICUS X-RAY OBSERVATIONS OF CYGNUS  
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NASA Goddard Space Flight Center  
Greenbelt, Maryland 20771

Submitted by:

California Institute of Technology  
Pasadena, California 91125



FINAL REPORT ON GRANT NSG 5208  
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The grant NSG 5208 was intended to provide funds for simultaneous X-ray and infrared measurements of Cygnus X-3.

This X-ray object is of interest because in the early 1970's, radio observations of the object showed a flaring which increased its total energy output by a factor close to 20,000. No visual observations are possible because of heavy extinction so except for X-ray or radio measurements, the only measurements possible are in the infrared. This region of the spectrum is interesting if simultaneous X-ray and infrared measurements could be made during a flare since such measurements might provide the necessary clue to understand the phenomenology and eventually the mechanism and then the origin of the flare energy. Data which define either the spectrum during one point in a flare or the time history of the development of a flare would be of special interest. See Mason et al. (1976, Ap. J., 207, 1) for references.

Simultaneous X-ray and infrared measurements were carried out during two seasons under this support. The infrared measurements, which constitute the substance of this grant work, were carried out with a specially built two detector infrared dewar. The detectors, InSb, were arranged so that 1.65 and 2.2  $\mu$ m broadband photometry was performed through one common diaphragm. By using this device, it was hoped to determine the slope of the energy distribution during a flare and thus to learn about the infrared spectrum and its changes during the flare. Updating of the detector system was partially supported by this and other NASA contracts.

Data obtained during 1977 August 20 - August 21 and 1978 August 30 - September 2 are shown in Figures 1-6; these were the photometric nights in a total of 10 nights of observations. Unfortunately, these data do not show flare phenomena but only show the characteristic quiescent periodicity which has been used to define the binary nature of Cyg X-3. The attempt to measure a flare was a gamble which was consciously taken and which, in this case, did not pay off. It is perhaps of interest that sporadic monitoring of Cyg X-3 in the past three years has failed to show flaring; this follows two years during which flaring was not uncommon.

The data do, however, provide a good record of the quiescent infrared behavior of Cyg X-3 during the 1977-1978 epoch. This is of some interest since Cyg X-3 displays small but perhaps significant long term changes in its quiescent behavior. An average curve of the intensity vs. phase is shown in Figure 7; this two-bumped curve is largely caused by a small fraction of the output. This is illustrated in Figure 8 which shows all the data plotted vs. phase.

The color behavior during the quiescent phase is illustrated in Figures 9 and 10. These data provide the first measurements of the spectral index of Cyg X-3 as a function of its amplitude within its 4.8<sup>h</sup> period. They indicate that, in fact, there is no change in the infrared color with either phase (Figure 9) or 2.2  $\mu\text{m}$  amplitude (Figure 10). This lack of change in 1.6-2.2  $\mu\text{m}$  color is of course limited in validity to amplitude changes characteristic of the quiescent behavior of Cyg X-3; whether it pertains to the much larger amplitude changes typical of the flare is open to conjecture.

Since Cygnus X-3 was not in a flare mode in the infrared or X-ray no detailed comparison between the X-ray and infrared data was made. It is planned that the infrared data will be published but purely for their archival value.

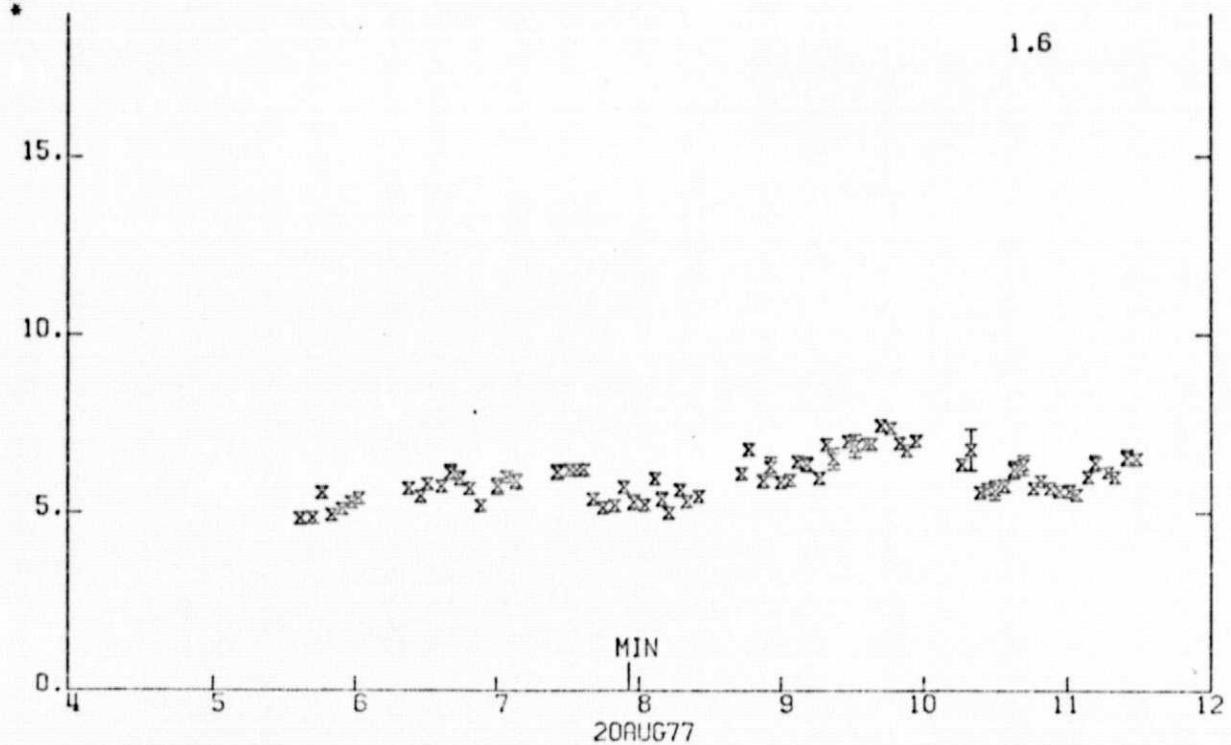
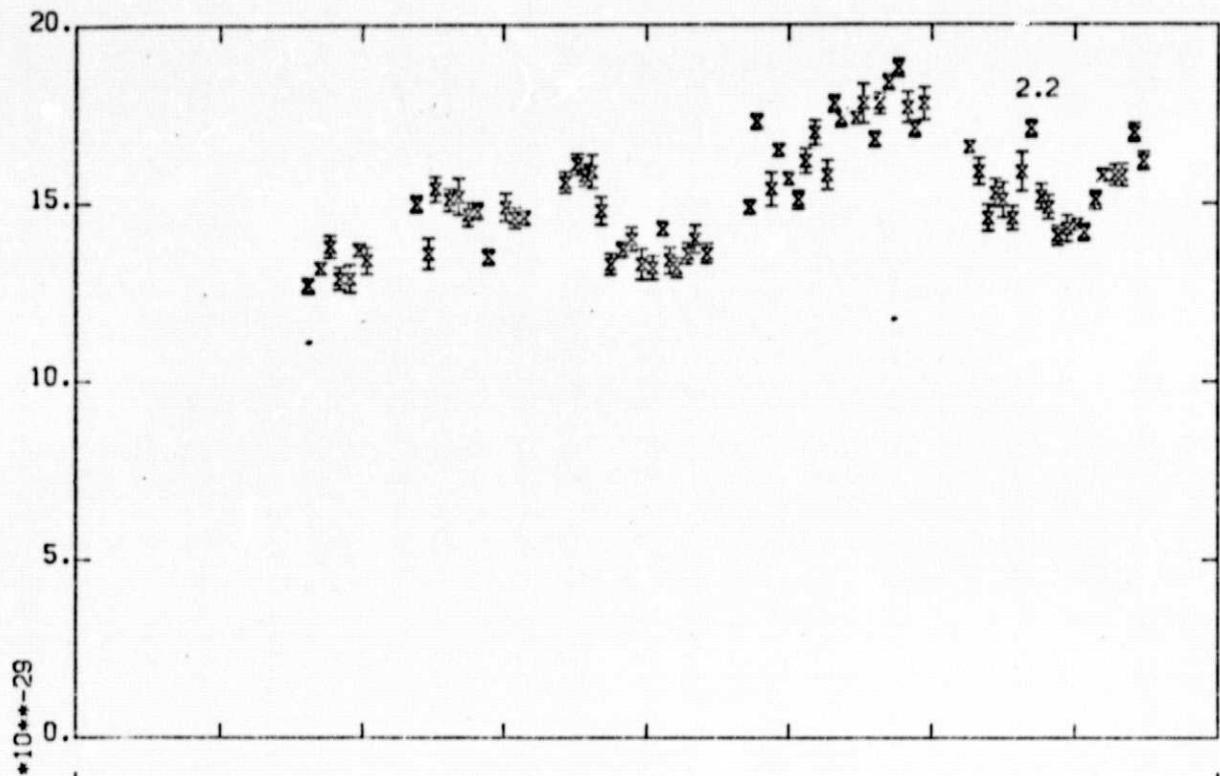


Figure 1

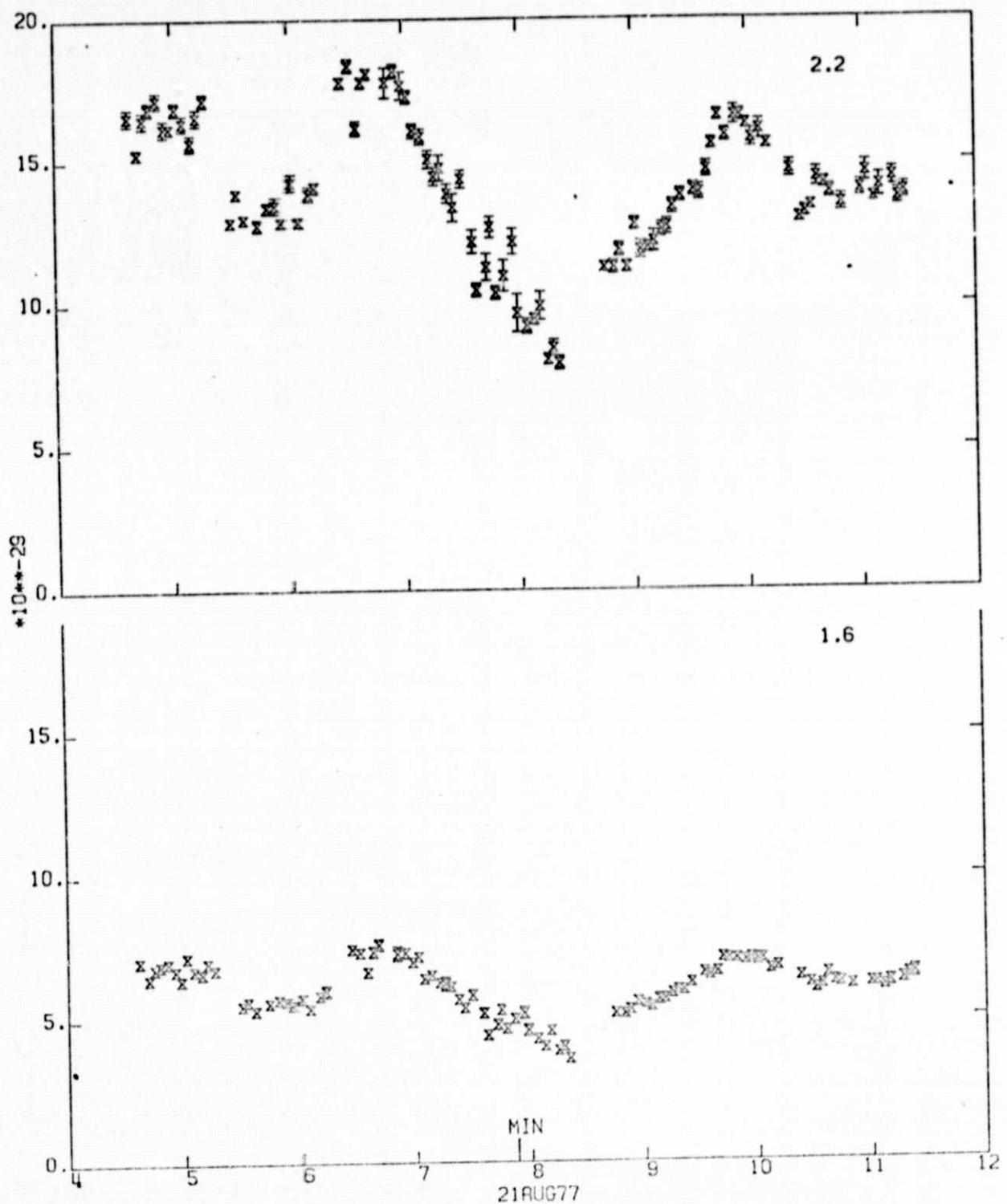


Figure 2

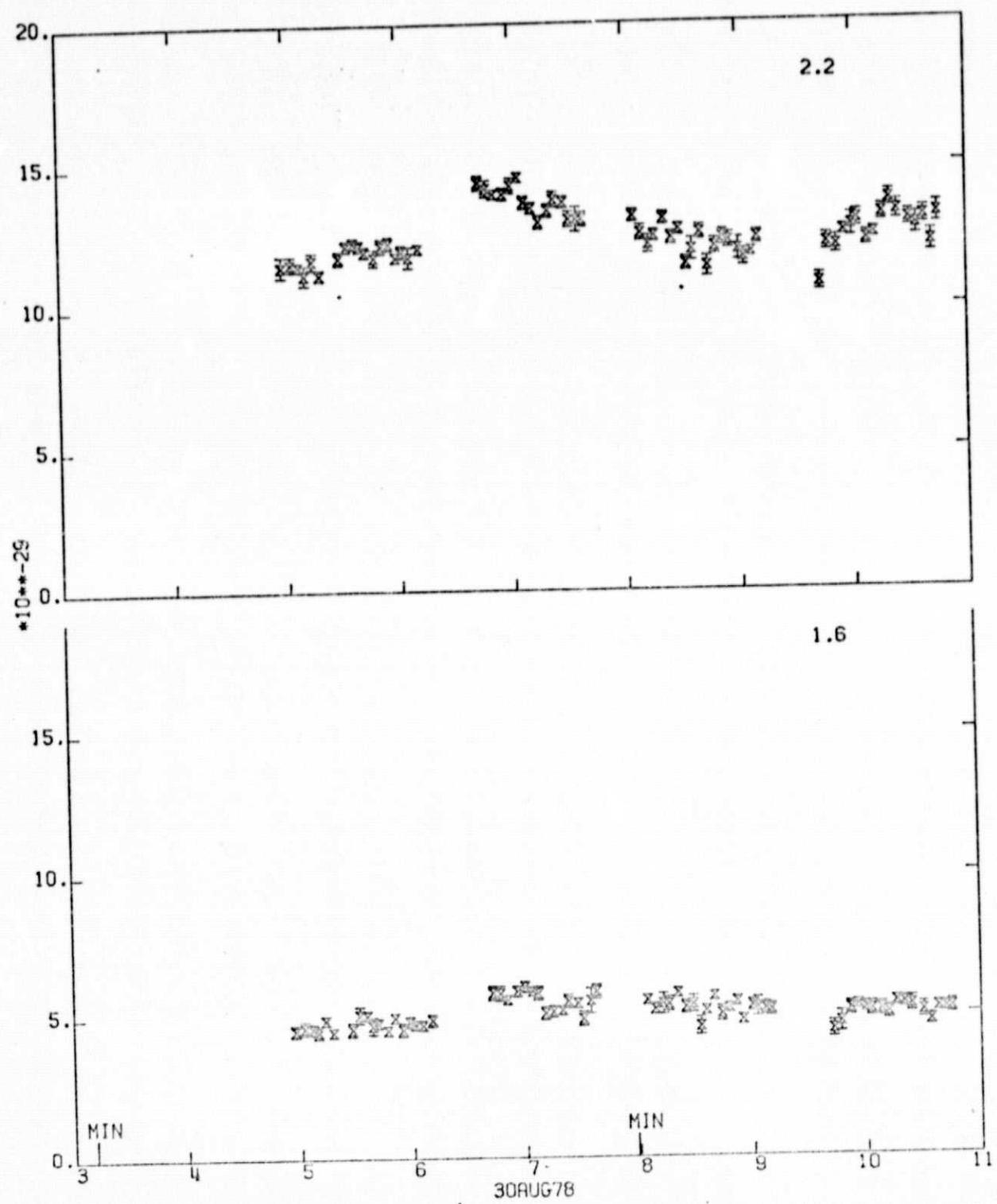


Figure 3

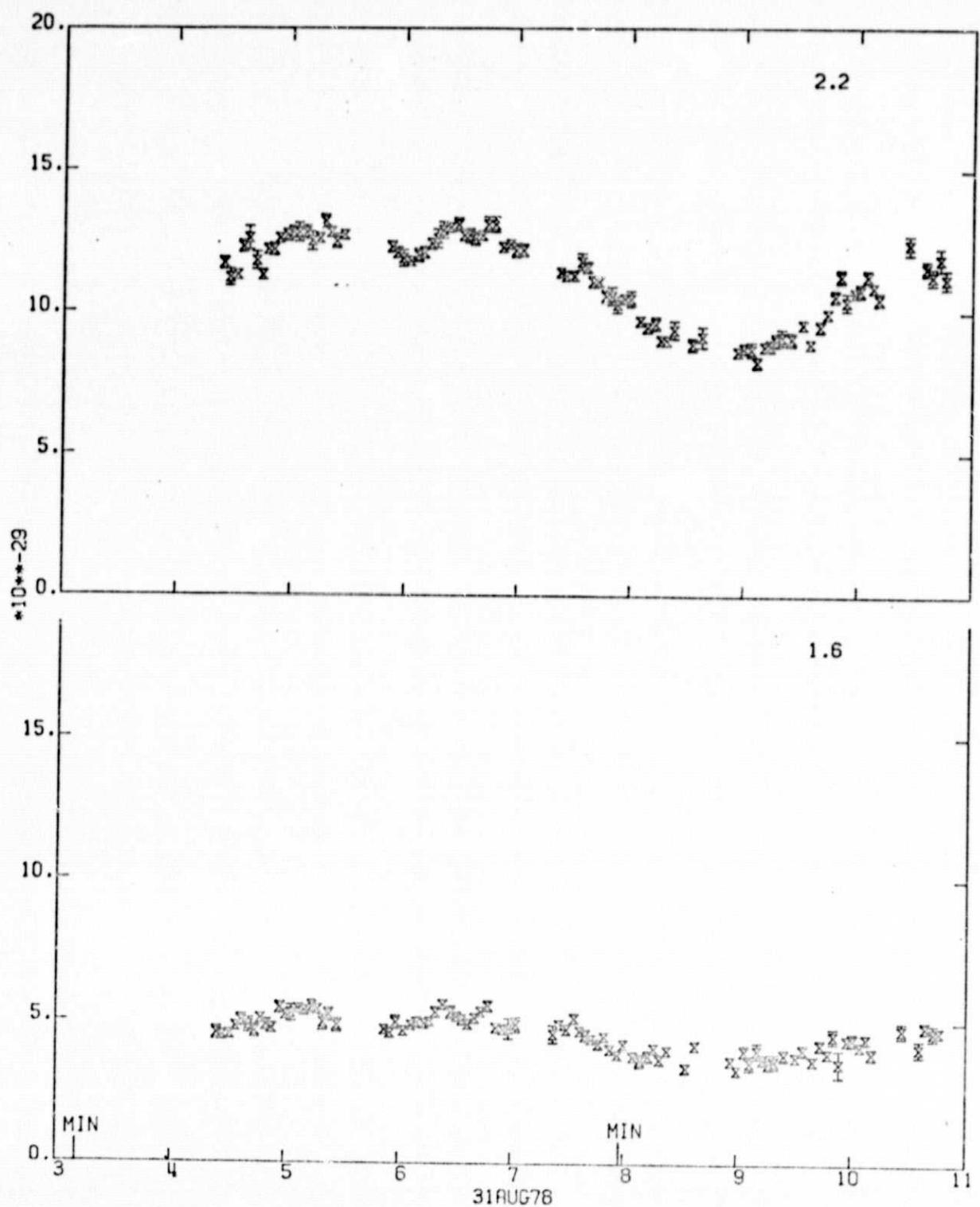


Figure 4

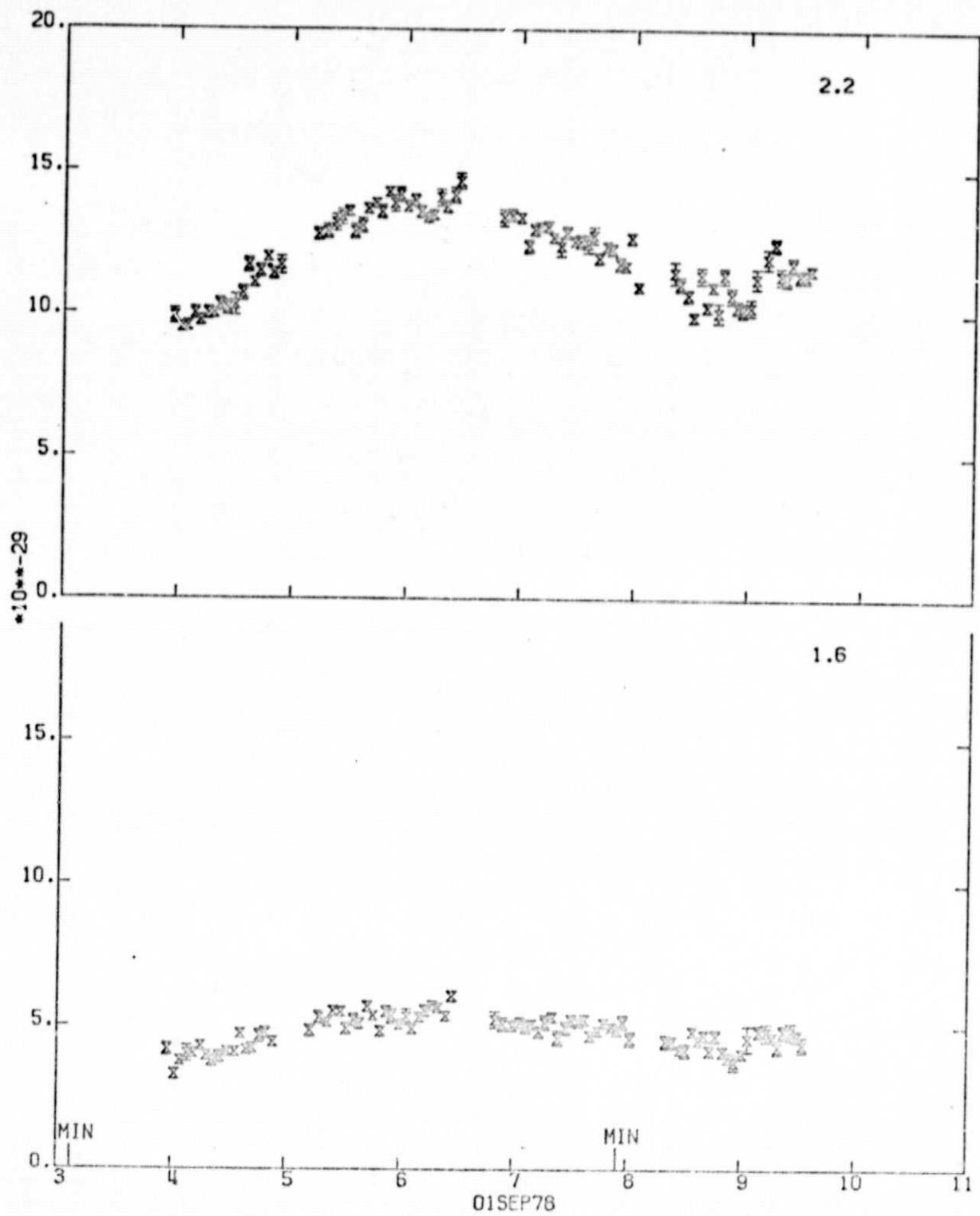


Figure 5

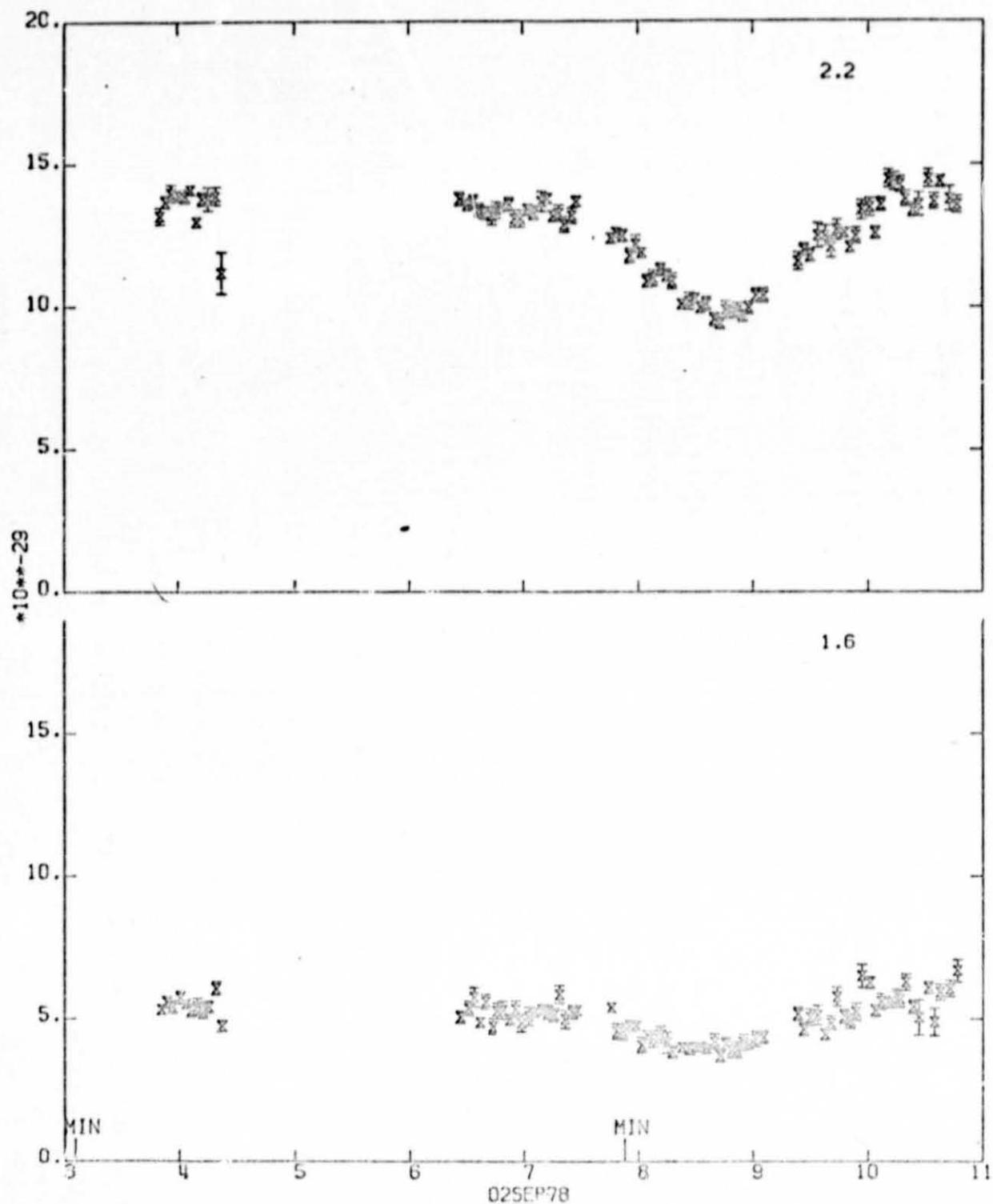


Figure 6

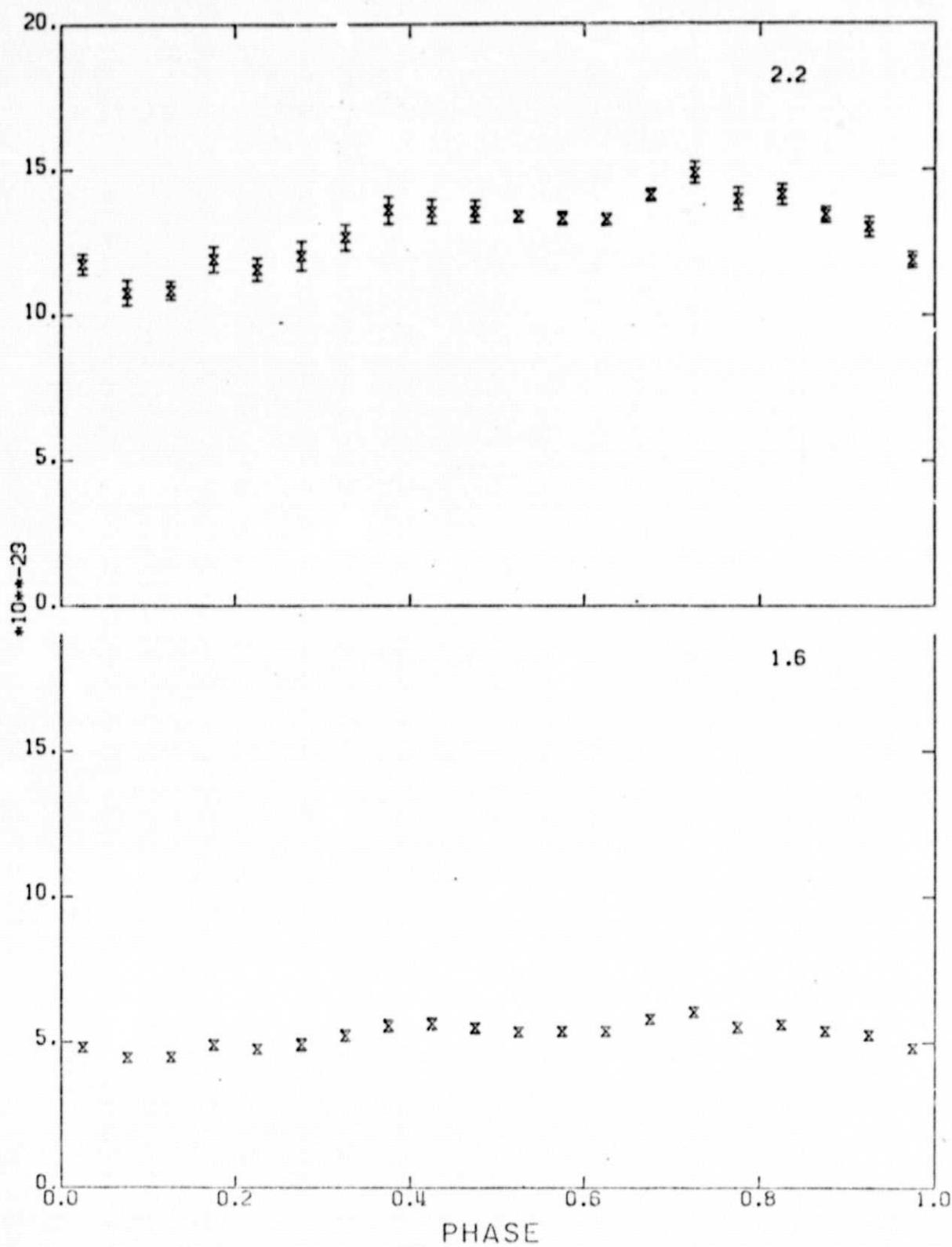


Figure 7

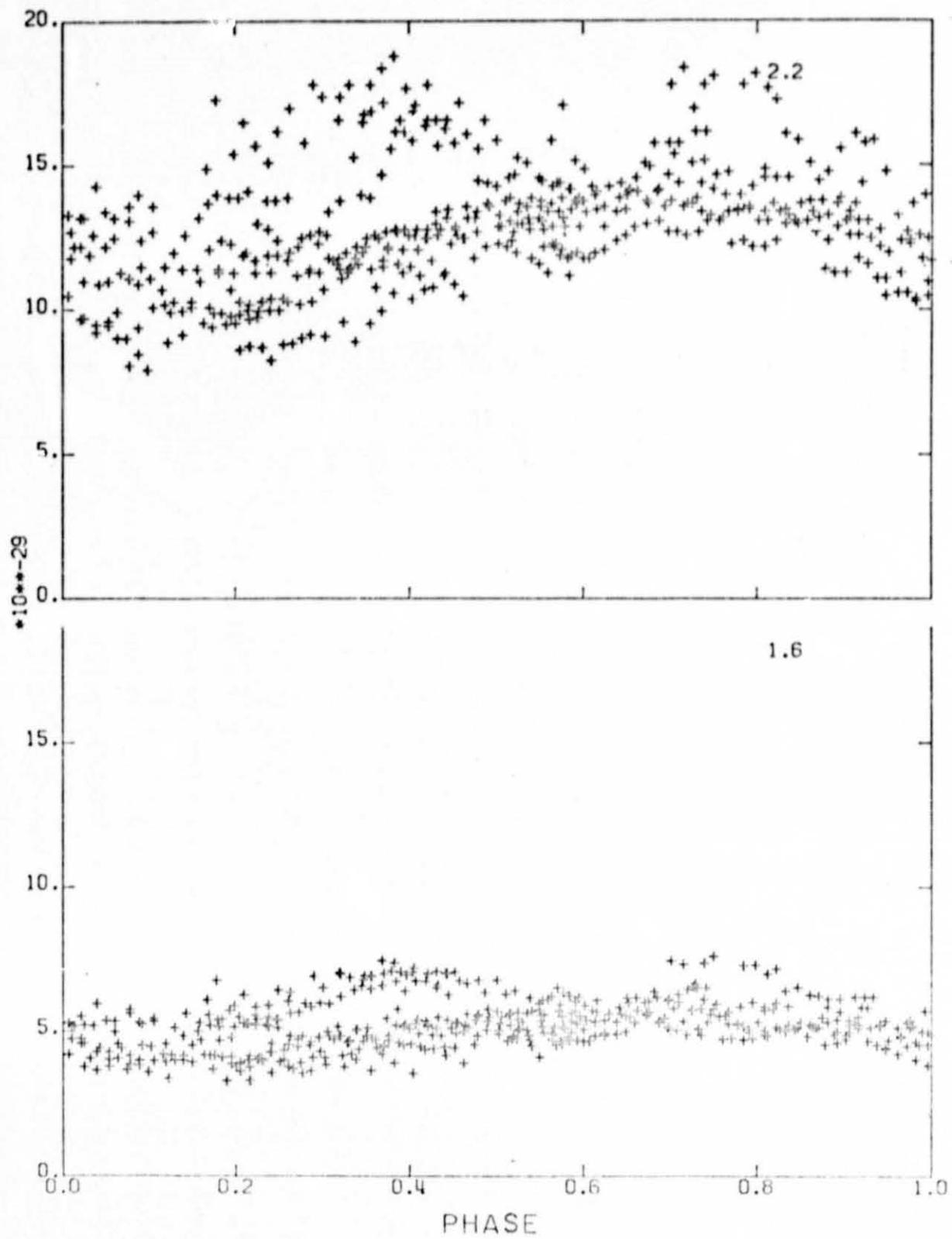


Figure 8

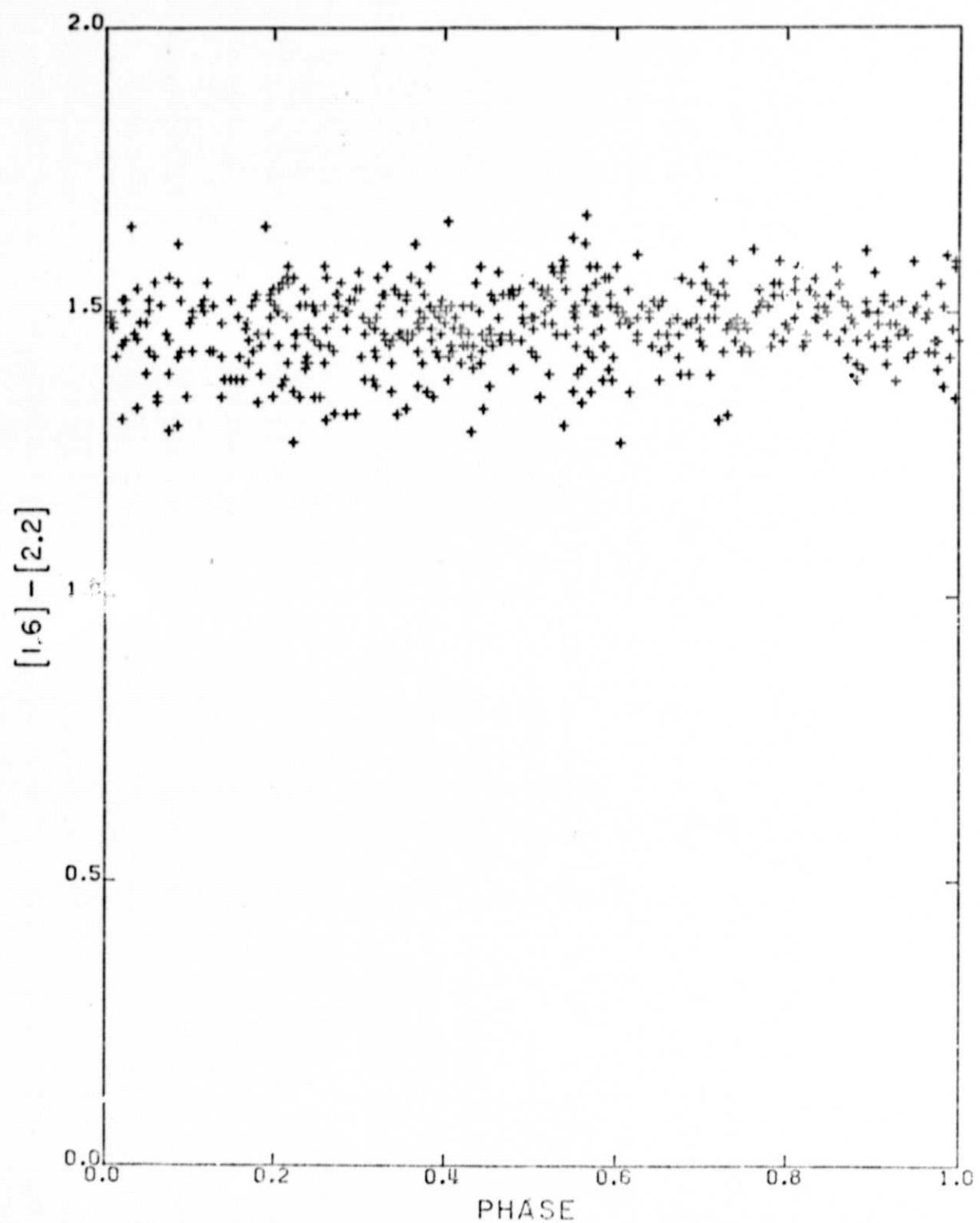


Figure 9

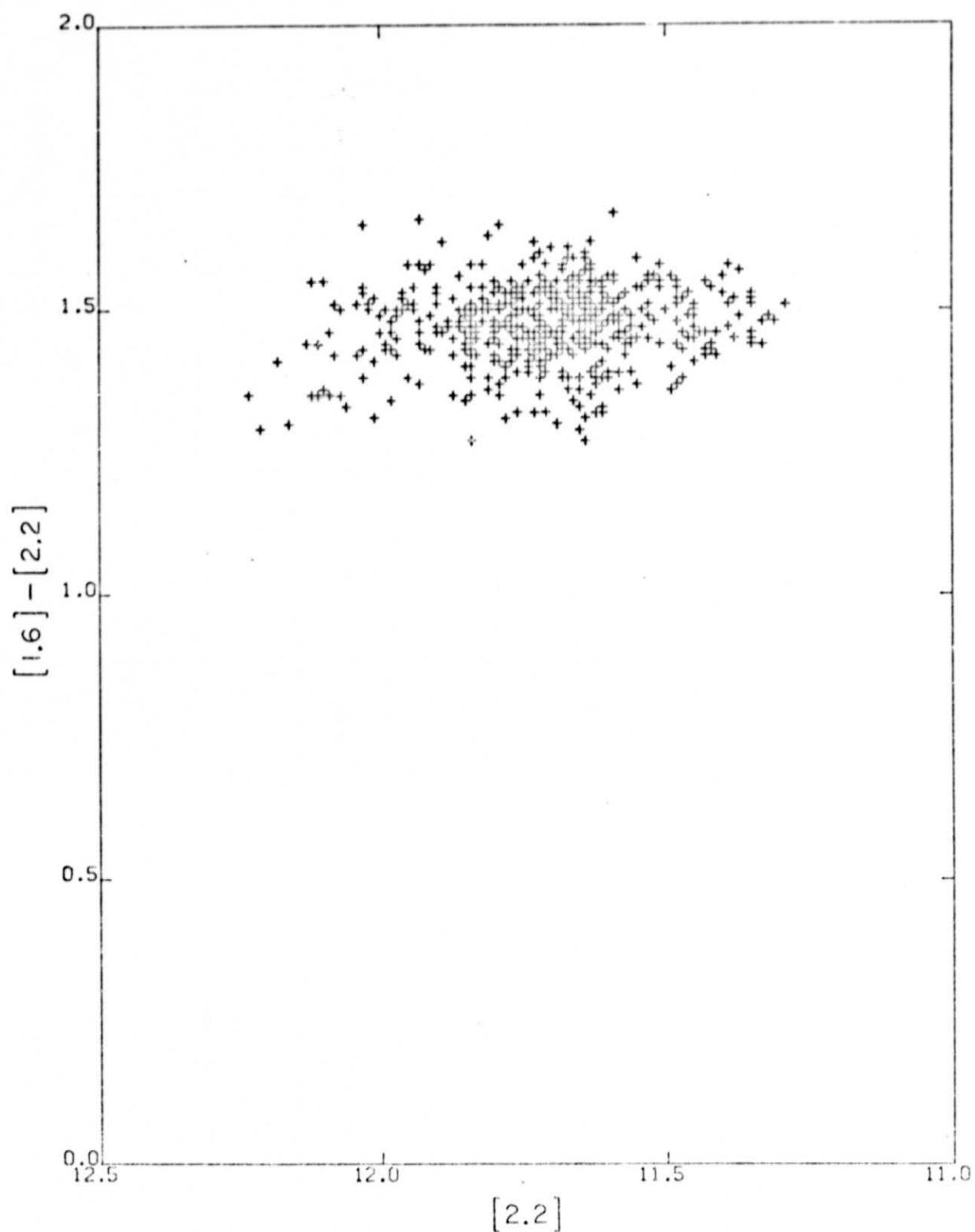


Figure 10